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ABSTRACT

One means to bridge the gap between theory and practice of industrial arts education is a system for curriculum development, course construction, and instructional material development using a conceptual-based approach. An essential task in this continuum is the identification of the instructional content base. Since industrial arts is the study of the concepts and principles associated with industrial technology, concept analysis is the appropriate procedure for identifying the universe of industrial arts instructional content. The process of concept analysis also attempts to cluster these concepts and principles that share some common criteria. Relationships of concepts within a cluster can be organized into a hierarchy. For the purposes of identifying the content base during the curriculum development process, a four-step hierarchy is normally adequate in delineating the concept universe of a technological cluster. Once the universe of a cluster has been analyzed and a concept hierarchy written, evaluated, and revised, specific concepts must be selected for courses of instruction and individual learning experiences. Vertical and horizontal articulation are two practical sampling plans for selecting content from the concept hierarchy for inclusion into courses and units of instruction. (Six figures are included.) (YLB)

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Conceptual-Based Teaching
in Industrial Arts

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Conceptual-Based Teaching in Industrial Arts

Introduction

Over the period of the past quarter century, considerable effort has been invested in identifying, expanding, and improving industrial arts instruction. The profession has constantly re-examined the definition of the field, the goals and objectives of instructional programs, and the teaching/learning strategies employed in industrial arts classrooms and laboratories.

The period of the 1960's produced a proliferation of "innovative programs" (Cochran, 1970) which sought to expand and improve industrial arts content and methodology. Many state departments of education have since disseminated curriculum guidelines and other resources to assist practitioners to evaluate and improve local industrial arts instruction. Textbook and instructional media publishers have underwritten the development of resources in diversified areas of industrial arts. Colleges and universities engaged in industrial arts teacher education have expanded subject matter and content coverage to more adequately prepare present and future teachers to reflect contemporary industry and technology. However, despite these indicators of positive progress described in the preceding scenario, there have been other indicators that suggest that industrial arts at the local level has not moved to adapt instruction to changed conditions

(Schmitt & Pelley, 1966; Devore, Maughan, & Griscom, 1979; Dugger, et al, 1980.) This discrepancy represents a serious threat to the future viability of industrial arts as a curriculum area in American education.

There are a number of plausible determinants contributing to the discrepancies in industrial arts practice (Israel, 1981). Discussion of the full range of these factors is beyond the scope of this presentation. However, one salient contributor to the lag between technical development and industrial arts teaching practice seems to be a lack of concern for applying curriculum development, course construction, and instructional technology procedures to local school situations. Industrial arts practitioners at all levels, including teacher educators, state and local supervisors, and classroom teachers, need to concentrate efforts to bridge the gap between theory and practice of industrial arts instruction. Industrial arts professionals must rekindle the interest in curriculum development, course construction, and instructional material improvement with the goal of preparing our programs to meet the needs of students in the last quarter of the twentieth century.

The objective of this presentation is to contribute to this bridge between theory and practice by describing a system for curriculum development, course construction, and instructional material development using a conceptual-based

approach. Procedures for identifying, categorizing, organizing, and presenting instruction based on the concepts related to industrial technology will be presented and discussed.

Establishing the Curriculum Base

Prior to delineating the content base for any instructional area, one must first define the field of interest: Drawing content from an unidentified or nebulous field results in confusion and irrational teaching. Many similar definitions for industrial arts have evolved over time through the work of Bonser and Mossman (1923), Olson (1963), and Wilber and Pendered (1967). For the purpose of clarification, the definition of industrial arts preferred here was given by Maley (1973) as follows:

Industrial arts, as a curriculum area, are those phases of general education which deal with technology--its evolution, utilization, and significance; with industry--its organization, materials, occupations, and products; and the problems and benefits resulting from the technological and industrial nature of society. (p. 3)

Central to this definition of industrial arts are three paramount themes: (1) general education, (2) industry, and (3) technology. General education refers to the life-long learning needed by all participants in a democratic society.

Industry is considered to be a social institution that uses technology to add value to materials by substantially changing their form (Suess, 1981, p. 7). Technology is the systematized and codified knowledge of doing (Brown, 1977, p. 2).

An essential task in the curriculum development, course construction, and instructional material development continuum is the identification of the instructional content base. This task is achieved by analyzing the defined field to identify the universe from which instructional content can be ultimately derived. The appropriate analysis methodology for identifying the industrial arts content universe has been a subject of professional concern. Industrial arts practitioners are often taught and often use an analysis procedure that is irrelative and insensitive to the needs of general education. This position was supported in an editorial in which Lux (1979) stated:

Trade and job analysis sends industrial arts teachers down the wrong road in their search for the substance of industrial technology Industrial arts teachers need to look to other forms of analysis for the core of their instruction. . . . Only when we look to other, relevant bases for identifying and organizing subject matter can we expect industrial arts to provide the industrial technological literacy students so desperately need. (p. 2)

Wolansky and DuVall (1975) reported a similar concern regarding the appropriate procedure for analyzing the industrial arts content base. Wolansky and DuVall wrote, "In the past, many curriculum planners have extracted content from occupational analysis rather than from a pool of scientific concepts. This approach tended to create premature concentration on acquisition of skills rather than on concept development" (p. 58).

The concerns of Wolansky and DuVall which are subscribed to here are predicated on the assumption that the universe forming the curricular base for industrial arts is best represented by scientific concepts and principles whose application give rise to technology and industry. Wolansky and DuVall (1975) further concluded:

It is more defensible to use a conceptually based approach in the selection of content for transfer of learning in similar contexts than it is to use a factual base. Concepts are not retired as quickly as facts. Most technological systems operated upon a core of scientific principles and concepts.

It is possible to group scientific concepts which have a commonality of conceptual themes. Such concepts give rise to technology, industry and careers. These concepts are appropriate content for industrial technology. (p. 63)

If the definition and assumptions provided by the preceding authors are valid, it is then logical to conclude that (a) industrial arts is the study of the concepts and principles associated with industrial technology; and (b) concept analysis is the appropriate procedure for identifying the universe of industrial arts instructional content. Therefore, it is extremely important for industrial arts practitioners to understand the nature of conceptual learning and the process of concept analysis.

Concepts and Conceptual Learning

The definition of the term "concept" is essential to this description of the curriculum development, course construction, and instructional material preparation process. According to Hauenstein (1973), "a 'concept' is an idea or thought that forms a mental image in your mind as well as in the minds of others" (p. 25). Gagné and Briggs (1974) stated that "a concept is a capability that makes it possible for an individual to identify a stimulus as a member of a class having some characteristic in common, even though such stimuli may differ from each other markedly" (p. 40). Spitzer (1977) held that "concepts are very simply groups of things that we give common names. They are our way of naming different things the same by treating them as part of the same category" (p. 23). The common theme identified in these definitions is the grouping, the classifying of thought,

ideas, and events. A visual example of such a concept grouping is presented in Figure 1.

Insert Figure 1 about here

Today we live in an age where humankind's acquisition and application of knowledge have increased at an almost incomprehensible rate. For example, the average senior citizen of this country has witnessed, in a relatively short time span, such technological developments as jet propulsion, television, atomic energy, analog computers, space exploration, and microprocessors. The time dimension required for further technological developments will surely be even more compressed (see Figure 2).

Citizens in such a technological society are continuously confronted with new information and developments that affect their daily lives. The validity of utilizing conceptual learning in this age of technology and information explosion was given by Spitzer, who stated, "We cannot afford to think of everything as unique and still be able to live our lives efficiently. Therefore, we must group our experiences into categories, or else we would have to investigate everything separately and rarely would get anything accomplished" (p. 23). The educational significance of conceptual learning was summarized by Martorella et al. (1972), who said:

Man lives in a conceptual world which he builds through both informal and systematic interaction.

Concepts enable us to simplify and organize our environment and to communicate efficiently with others. While each of us may be said to have truly unique concepts of objects or events, we share with others at least the critical or criterial attributes of the concepts. This minimal commonality should provide the basic instructional goal for teachers in classroom settings.

(p. 20)

Insert Figure 2 about here

Concept Analysis

The knowledge of concepts and conceptual learning can be very helpful to the industrial arts practitioner interested in curriculum development, course construction, and instructional material improvement. Through the application of concept analysis, the scientific principles giving rise to technology and industry can be identified and classified, forming the content references from which classroom and laboratory instruction can be ultimately derived.

The process of concept analysis can be described as a classification method for organizing phenomena having rules for defining relevant categories, including sets of positive instances or exemplars with attributes and a name. The key elements of this description have been defined as follows:

Rules are the definitions or formulas specifying the attributes of the concept.

Attributes are those characteristics which are the identifying features of a concept, and which enable one to distinguish between exemplars and nonexemplars.

Exemplars may be regarded as positive instances of the concept: Nonexemplars as negative examples.

Names are the symbols commonly used by a culture to identify or label a concept.

(Martorella et al., 1972, p. 7)

The task of the curriculum developer in applying this analysis model is to identify concepts from the universe of industrial technology to provide the base for subsequent course construction and instructional material development. Figure 3 illustrates a concept identified from the universe of technology related to industrial materials and processes.

Insert Figure 3 about here

The very nature of knowledge suggests that there are an infinite number of concepts in the universe. The process of concept analysis attempts to cluster those concepts and principles that share some common criteria. The relationships of the concepts within such a cluster can be organized by

forming a hierarchy of superordinate and subordinate concepts. A diagrammatic representation of a concept hierarchy is shown in Figure 4.

Insert Figure 4 about here

For the purposes of identifying the content base during the curriculum development process, a four-step hierarchy is normally adequate in delineating the concept universe of a technological cluster. Here, the job of the curriculum developer is to provide the appropriate documentation in the form of a detailed outline of interrelated concepts and principles. To complete this task, the developer should:

1. Conceptualize the scientific principles related to industry and technology.
2. Formulate concept rules for classification purposes.
3. List identified concepts in a random order.
4. Examine attributes and exemplars to find clusters of interrelated concepts.
5. Identify higher-order (superordinate) concepts to form mutually exclusive categories.
6. Establish subordinate (lower-order) concept classifications that are totally incumbent within the higher-order concepts.
7. Write concept hierarchy in outline form.
8. Evaluate and revise concept hierarchy in view of curriculum development needs.

An example concept hierarchy developed for the cluster of concepts related to industrial materials and processes is presented in Figure 5.

Insert Figure 5 about here

Putting Theory Into Practice

Once the universe for a technological cluster has been analyzed and a concept hierarchy written, evaluated, and revised, specific concepts must be selected from the hierarchy forming the specifications for courses of instruction and individual learning experiences. Concept selection should be guided by the developmental needs of students in the target population, the instructional time allocation, facility, and budget of the industrial arts program, and other ancillary factors (Sarapin & Starkweather, 1981).

Vertical and horizontal articulation are two practical sampling plans for selecting content from the concept hierarchy for inclusion into courses and units of instruction. A vertical concept articulation plan concentrates on the higher-order concepts as organizers for a course or unit of instruction. Vertical articulation is appropriate for the more broadly conceived instructional experiences grouped into such courses as Industrial Materials and Processes, Industrial Communications, Energy and Power, and Production Simulation.

A horizontal articulation plan concentrates on the subordinate concepts within a higher-order concept from the hierarchy and produces courses or units much narrower in scope and specificity in instructional orientation. Horizontal articulation is appropriate for grouping concepts into such courses as Forming and Fabricating Processes, Energy Conversion and Power Utilization, and Graphic Communications. An example of vertical and horizontal instructional sampling is shown in Figure 6.

Insert Figure 6 about here

Conclusion

The application of conceptual-based teaching is not intended to transform the dynamic activity orientation of industrial arts into a static classroom subject. Moreover, "we must make certain that the words and other concepts the child learns are backed up by experiences" (Spitzer, 1977, p. 26). Conceptual-based teaching in industrial arts should incorporate such elements of experiential learning as building, comparing, confirming, constructing, evaluating, experimenting, investigating, inquiring, interpreting, observing, questioning, reporting, testing, visiting, viewing, and other forms of exploration humankind has used throughout the ages to fashion our technological world.

A major task of the classroom teacher then becomes the selecting and structuring of the learning environment to

foster conceptual learning. Conceptual-based industrial arts activities employ such diversified instructional methods as computer-assisted/managed instruction, field trips, films, games, group projects, individual projects, instructional modules, laboratory-learning activity packages, programmed instruction, seminars, and simulations.

Industrial arts practitioners at all levels of instruction must contribute to the effort required in bridging the gap between the theory and practice of instruction. Industrial arts professionals must continue to apply alternative procedures for delineating the content base of industrial technology. Industrial arts personnel must continue to expand the utilization of alternative dynamic instructional teaching strategies.

Concept analysis is a workable model for identifying and organizing content related to industry and technology. Conceptual-based teaching is a dynamic approach to preparing our students for entering the technological twenty-first century.

Selected References

- Bonser, F. B., & Mossman, L. C. Industrial arts for elementary schools. New York: Macmillan, 1923.
- Brown, K. W. Model of a theoretical base for industrial arts education. Academy of Fellows Monograph 1. Washington, DC: American Industrial Arts Association, 1977.
- Brown, K. W. Identifying industrial arts. Man/Society/Technology, 1973, 32, 211-213.
- Carrel, J. J. Cluster curricula in industrial teacher education: Are they really clusters? Which ones are being used and how have they been determined? Journal of Industrial Teacher Education. 1978, 15(2), 35-41.
- Cochran, L. H. Innovative programs in industrial education. Bloomington: McKnight, 1970.
- DeVore, P. W., Maughan, G. R., & Griscom, W. E. Influence of technology on industrial arts subject matter. In Martin, G. E. (Ed.), Industrial arts education: Retrospect, prospect. Bloomington: McKnight, 1979.
- DuVall, J. B. The cluster technologies approach--New potentials for industrial arts in the public schools. Proceedings of the American Industrial Arts Association 37th Conference, 1975, 124-130.
- Dugger, W. E., Bame, A. E., Miller, C. D., Dixon, J. D., Young, L., Holmes, J. A., Pinder, C. A., Rieber, L., & Pesce, F. Special feature on the status of industrial arts education. Journal of Industrial Teacher Education, 1980, 18(1), 3-8.

- Gagné, R. M., & Briggs, L. J. Principles of instructional design. New York: Holt, Rinehart and Winston, 1974.
- Hauenstein, A. D. Curriculum planning for behavioral development. Worthington, OH: Charles A. Jones, 1973.
- Israel, E. N. Stagnation in industrial arts, part 1. Man/Society/Technology, 1981, 40(4), 3-5.
- Israel, E. N. Stagnation in industrial arts, part 2. Man/Society/Technology, 1981, 40(5), 9-11.
- Kenneke, L. J., Nystrom, D. C., & Stadt, R. W. Planning and organizing career curricula: Articulated education. Indianapolis: Howard W. Sams, 1973.
- Klausmeier, H. J., Ghatala, E. S., & Frayer, D. A. Conceptual learning and development: A cognitive view. New York: Academic Press, 1974.
- Lux, D. G. Trade and job analysis--The scourge of IA. School Shop, 1979, 38(7), 2.
- Maley, D. The Maryland Plan: The study of industrial technology in the junior high school. New York: Bruce, 1973.
- Martorella, P. H., Jensen, R. S., Kean, J. M., & Voelkner, A. M. Concept learning: Designs for instruction. Scranton: Intext Educational Publishers, 1972.
- Olson, D. O. Industrial arts and technology. Englewood Cliffs, NJ: Prentice-Hall, 1963.
- Sarapin, M. I., & Starkweather, K. N. Curriculum development: Placing the learner at the center of the instructional process. Journal of Epsilon Pi Tau (in press).

Schmitt, M. L., & Pelley, A. L. Industrial arts education:

A survey of programs, teachers, students, and curriculum

(Circular No. 791, OE 33038). Washington, DC: U. S.

Department of Health, Education, and Welfare, 1966.

Suess, A. R. Preparing teachers for the technological future.

School Shop (in press).

Spitzer, D. R. Concept formation and learning in early childhood. Columbus: Charles E. Merrill, 1977.

Wilber, G. O., & Pendered, N. C. Industrial arts in general education (3rd ed.). Scranton: International Textbook, 1967.

Wolansky, W. D., & DuVall, J. B. Curriculum relevance for industrial arts. Journal of Industrial Teacher Education, 1975, 12(4), 56-66.

Classification Rule: Capable of being magnetized
or attracted by a magnet.

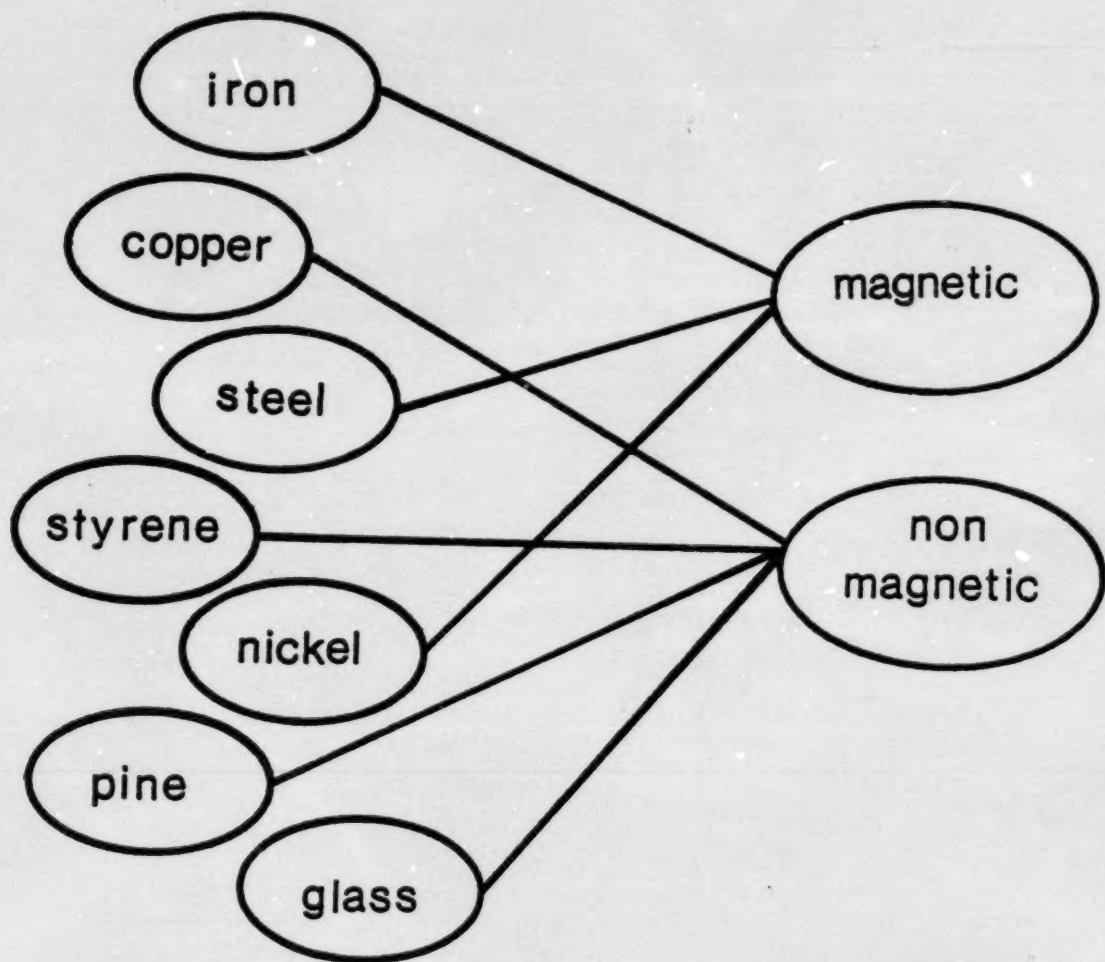


Figure 1. The Concept "Magnetic".

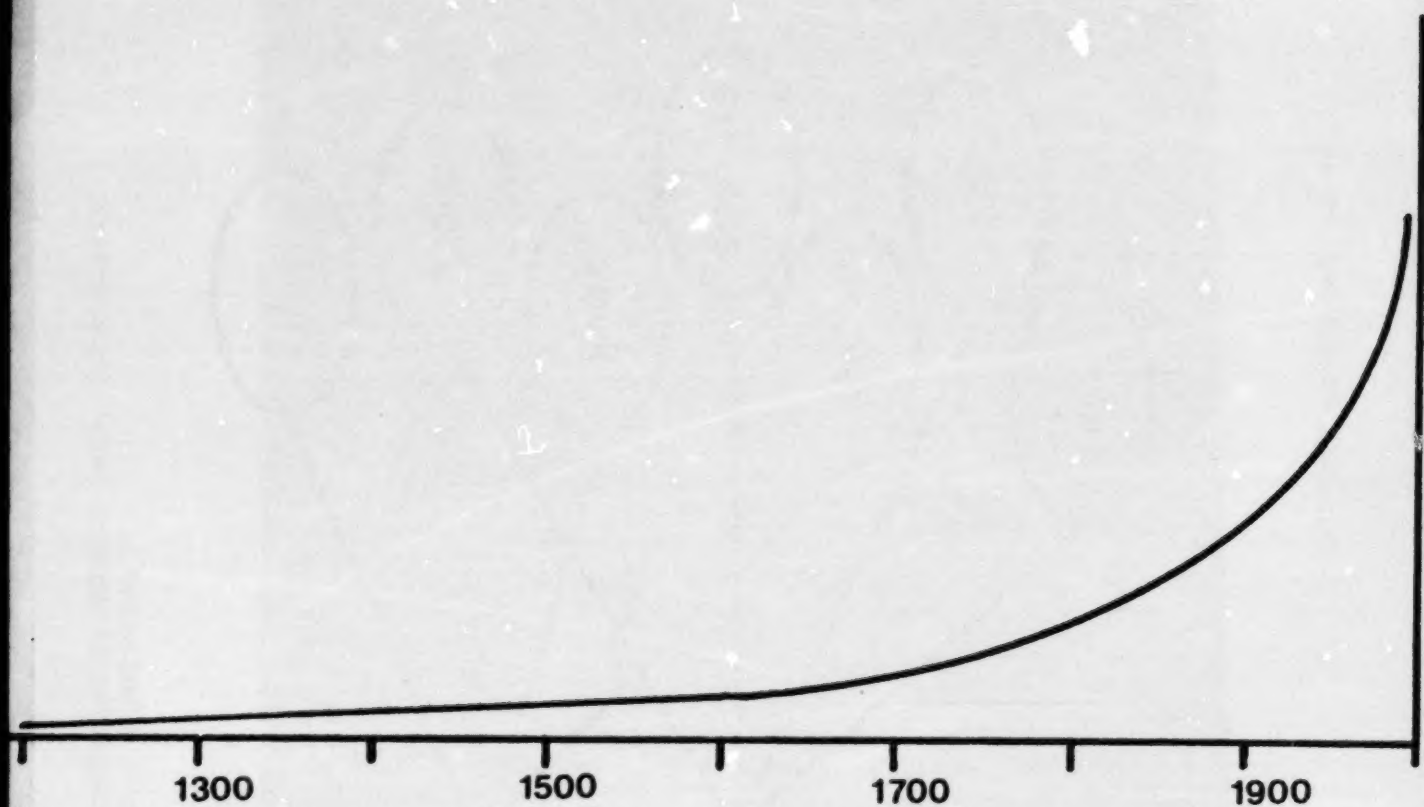


FIGURE 2. THE PROFILE OF CHANGE [Maley, 1973b, p. 11]

CONCEPT RULE: LONG CHAIN CARBON BOND
SYNTHETIC MATERIAL

CONCEPT
ATTRIBUTE: MOLDABLE
RESINOUS
REACTS TO HEAT

POLYSTYRENE	MAPLE
POLYETHYLENE	PINE
EPOXY	BALL CLAY
POLYESTER	LOW CARBON STEEL

21

universe: materials

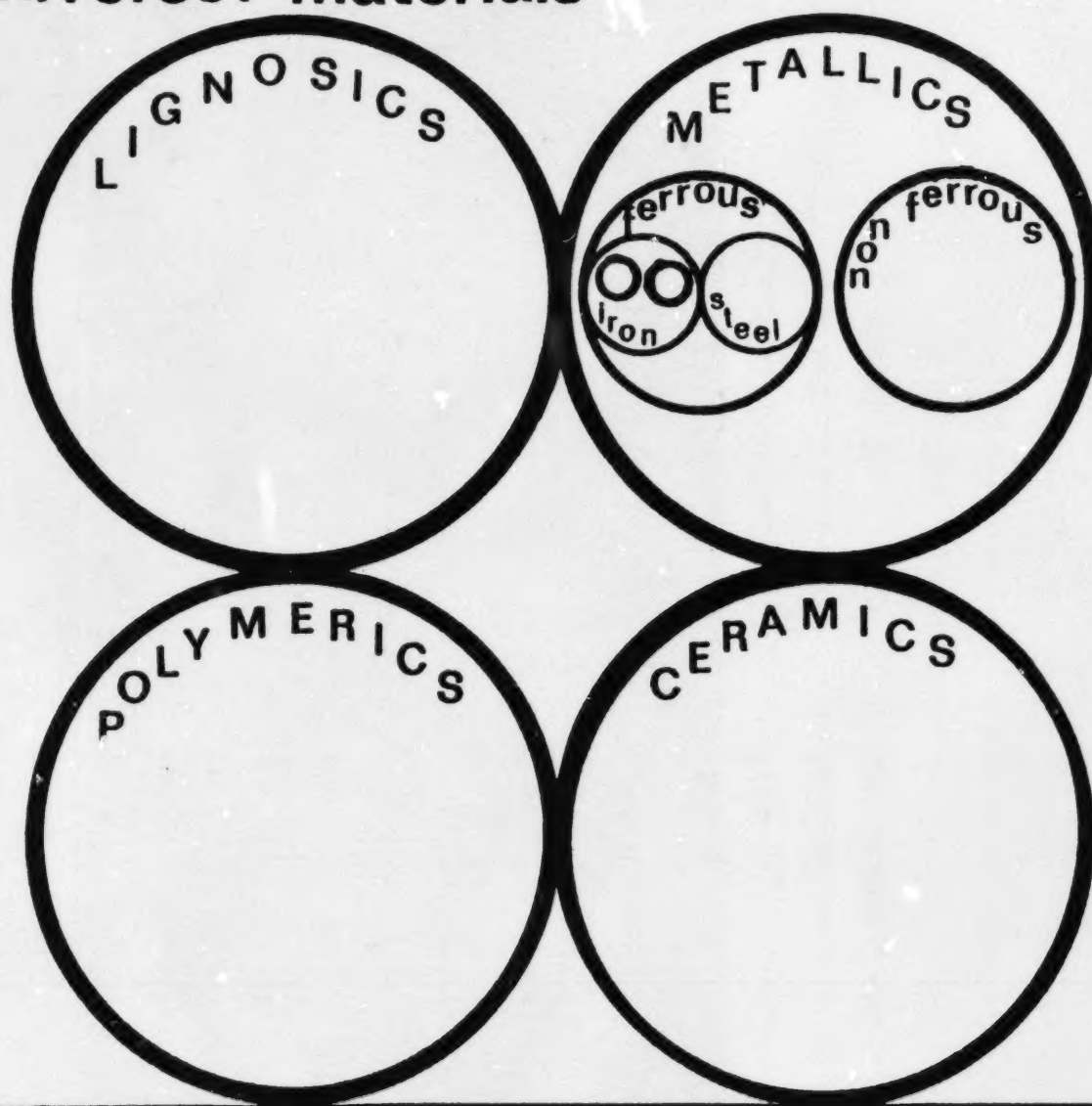


Figure 4. A visual concept hierarchy: materials

MATERIALS PROCESSING

- 1.0 MATERIALS
 - 1.1 CERAMICS
 - 1.1.1 IGNEOUS
 - 1.1.2 METAMORPHIC
 - 1.1.3 SEDIMENTARY
 - 1.2 LIGNOSICS
 - 1.2.1 CONIFEROUS
 - 1.2.2 DECIDUOUS
 - 1.3 METALLICS
 - 1.3.1 FERROUS
 - 1.3.2 NON FERROUS
 - 1.4 POLYMERICS
 - 1.4.1 ELASTOMERS
 - 1.4.2 THERMOPLASTICS
 - 1.4.3 THERMOSETTING PLASTICS
 - 1.4.3.1 EPOXY
 - 1.4.3.2 POLYESTER
 - 1.4.3.n
- 2.0 PROCESSING
 - 2.1 CONDITIONING
 - 2.1.1 EXTERNAL CONDITIONING
 - 2.1.2 INTERNAL CONDITIONING
 - 2.2 JOINING
 - 2.2.1 ADHESIVE JOINING
 - 2.2.2 COHESIVE JOINING
 - 2.2.3 MECHANICAL JOINING
 - 2.3 SEPARATING
 - 2.3.1 MECHANICAL-CHIP SEPARATING
 - 2.3.2 MECHANICAL NON-CHIP SEPARATING
 - 2.3.3 NON MECHANICAL SEPARATING
 - 2.4 SHAPING
 - 2.4.1 CASTING & MOLDING
 - 2.4.2 FORMING
 - 2.4.2.1 BENDING
 - 2.4.2.2 DRAWING
 - 2.4.2.n

Figure 5. Four-step concept hierarchy

VERTICAL ARTICULATION (BROAD CONTENT SELECTION)
AMONG CONCEPTS

INSTRUCTIONAL

UNIT: INDUSTRIAL MATERIALS PROCESSING

CONTENT ORGANIZERS:

MATERIALS

CERAMICS
LIGNOSICS
METALLICS
POLYMERICS

PROCESSING

CONDITIONING
JOINING
SEPARATING
SHAPING

HORIZONTAL ARTICULATION (NARROW CONTENT SELECTION)
WITHIN A CONCEPT

INSTRUCTIONAL

UNIT: MECHANICAL-CHIP SEPARATING

CONTENT ORGANIZERS:

ABRADING
BORING
BROACHING
DRILLING
FILING
ETC.

GRINDING
MILLING
PLANING
REAMING
SAWING
ETC.

Figure 6. Two methods of concept selection in instructional development.